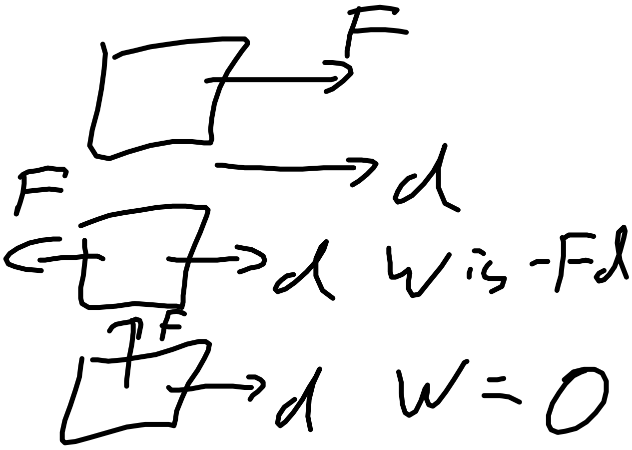
Work = Fd

units: Joule, J



$P = \frac{W}{t}$

units: Watts, W

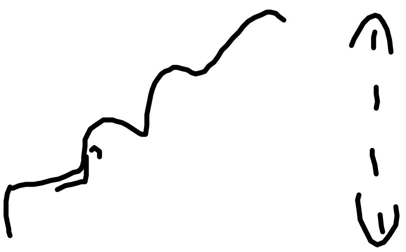
or horsepower hp = 746 W

1. A 50.0 kg student runs up 23 stairs, 0.12 m high and 0.24m wide in 2.5s. Determine

a) the weight of the student

F_g=mg = 50.0x9.80=490.0 =490. N

b) the distance up the stairs



h = 0.12m x 23 stairs

= 2.76 m = 2.8 m

c) the distance sideways of the stairs

d= 23x0.24=5.52 m

d) the work done by the student against gravity

W=Fd = 490Nx2.76m = 490x2.76=1,352.4

1.35 kJ = 1.35×10^3 J

e) the work done by gravity

e) the work done by gravity
= -1.35 kJ (force is opposite the displacement)

f) the work done by the normal force
W=0 there is no displacement
(the normal force does work when you are in an elevator or in the car, the back of the seat pushes on you)

g) the power of the student in Watts, and in horsepower 1hp = 746W
P=W/t = 1,352.4/2.5=540.96 540.96/746=0.7251
P=540W = 0.73 horsepower

1. You leave a 100W light bulb on for 8.0 hours a day for a year. If BC Hydro charges $0.12 per kilowatt-hour

a) how much energy did you use in kilowatt-hours? In Joules?
100Wx8hours/day x 365.25
100x8x365.25=292,200 Whrs = 292 kWhrs
J=Nm
W=J/s
292,200 J/s hours = 292200J/sx3600s
292200x3600=1051920000 = 1.1×10^{9}J

b) How much does it cost to light the bulb?
292 kWhrs x $0.12/kWhrs
292x0.12=35.04

$35 per year to run one light bulb.

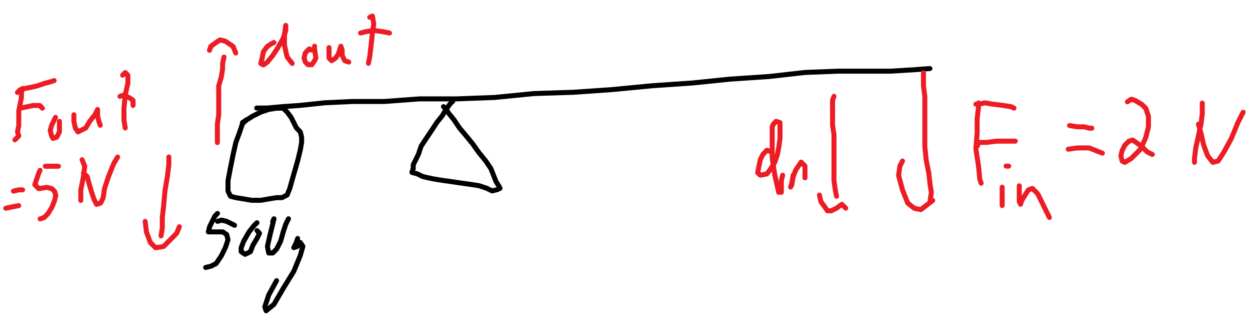
What if you used a high efficiency bulb, P=25W for the same brightness?
$35.04/4=$8.76
you save 35.04-8.76=26.28 $26per year

1. run up the stairs and calculate your power
measure: Mass____, time____, height of each stair____ x the number of stairs____

20minutes of classwork
p199Q1-4, p202 Q5,6 p203Q9-12

Simple Machines, Mechanical Advantage and Efficiency

Look at a lever



Ideal Machine no work is lost to Friction.

Types of simple machines:
pulleys, levers, wheel and axel, wedge,

Ideal machine the work in = work out
(in the lever example, the work out is the work done by the lever lifting the mass, the work in is the work you do on the lever)

$F_{in}d_{in} = F_{out}d_{out}$ $F_{out}/F_{in} = d_{in}/d_{out}$
we define mechanical advantage, MA = F_{out}/F_{in}

from the above equation we see

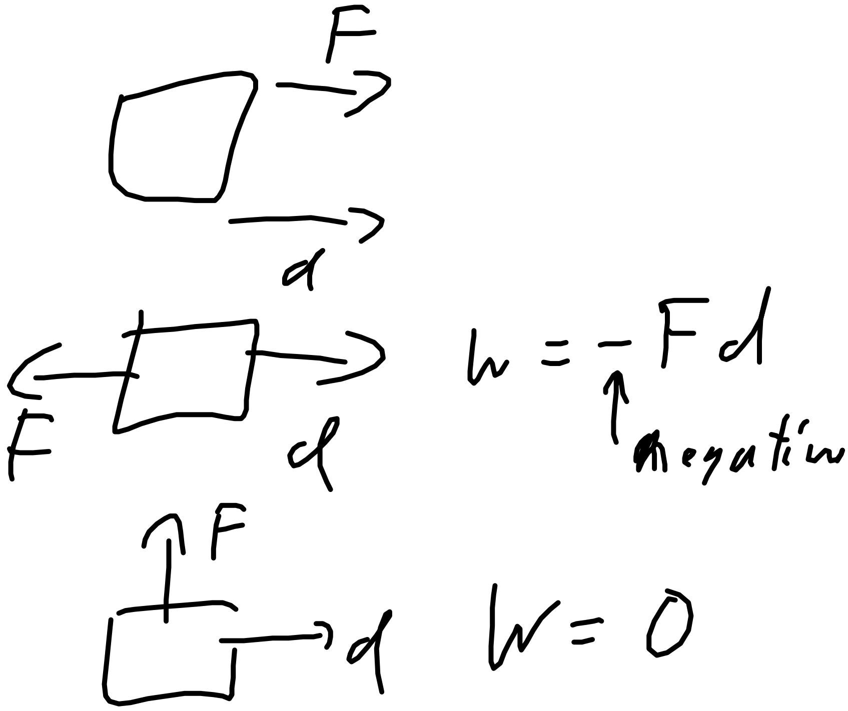
Ideal Meachanical Advantage,
IMA=$F_{out}/F_{in}= d_{in}/d_{out}$
eg. You use a jack (lever) to lift a car. If it requires 2000 N to lift one wheel 0.10m using a jack repeatedly through 1.5m

a) what is the ideal mechanical advantage (use the displacements)
b) what minimum force is required on the jack?
c) If you push the jack with 150N to lift the car, what is the Mechanical advantage and efficiency of the jack?

a) IMA=$F_{out}/F_{in}= d_{in}/d_{out}$ = 1.5m/0.1m = 15X
b) F_{in} =F_{out} /IMA = 2000N/15= 133N
c) MA = 2000N/150N = 2000/150=13X
efficiency = Wout/Win x 100%

= Foutdout/Findin x 100%
= 2000N x 0.10m /150Nx1.5m x100%
= 89% efficient

Work, W=Fd



units: Joule, J
Power, P=W/t
units: Watts, W

1. A 50.0 kg student runs up 23 stairs, 0.12 m high and 0.24m wide in 2.5s. Determine

a) the weight of the student

F_g=

F_g=mg = 50kg x 9.80N/kg = 490N

b) the distance up the stairs

height = 0.12m x 23stairs =

0.12x23=2.76 m = 2.8m

height = 0.12m x 23stairs =

0.12x23=2.76 m = 2.8m

c) the distance sideways of the stairs

0.24x23=5.52 m 5.5m

d) the work done by the student against gravity

W=Fd = 490Nx2.76m (up/down only)

490x2.76=1,352.4

1.4 kJ = 1.4×10^3J

e) the work done by gravity

W=-1.4 kJ = -1.4×10^3J

f) the work done by the normal force

W=0 the floor doesn't move

(when does the normal force do work? on a trampoline, elevator, or seat of the car, the back pushes on your back.)

g) the power of the student in Watts,

P=W/t = 1,352.4J/2.5s

1,352.4/2.5=540.96

540W

and in horsepower 1hp = 746W

540.96 W (1hp/746W)

540.96/746=0.7251

0.73hp

540.96/746=0.7251
0.73hp

1. You leave a 100W light bulb on for 8.0 hours a day for a year. If BC Hydro charges $0.12 per kilowatt-hour
a) how much energy did you use in kilowatt-hours? In Joules?

100W x 8.0hours x365.25
100x8x365.25=292,200 Whrs
2.9×10^{2}kWhrs

How much does it cost to light the bulb?
292x0.12=35.04
$35 per year

What if you used a high efficiency bulb, P=25W for the same brightness?
35/4=8.75 it will only cost $8.8, a savings of 35.04-8.75=26.29 $26 per year

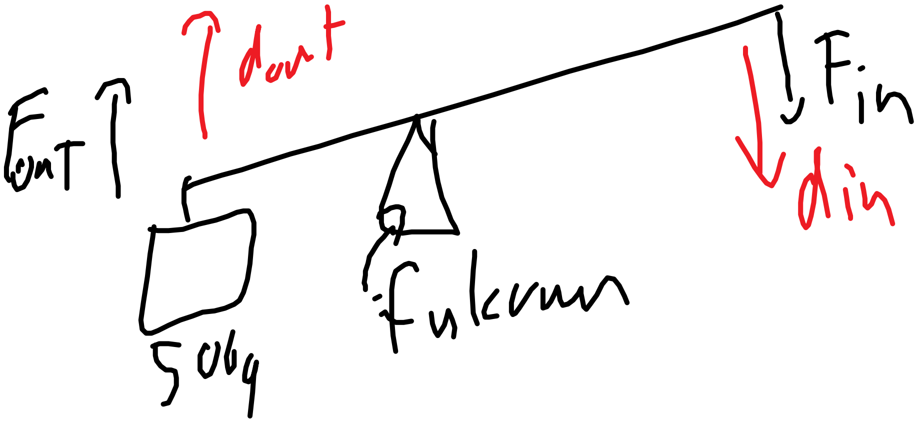
1. run up the stairs and calculate your power measure: Mass____, time____, height of each stair____ x the number of stairs____

- ☐ p199-203 problems 1-4, 5,6, 9-12 work for 20 minutes,
- ☐ then we will introduce Simple Machines and

efficiency

look at a lever

$W = Fd$



Ideal machine, the work out=work in,
no energy/work lost to frictional forces

Types of simple machines:
Lever, pulley, wedge, wheel and axel

Mechanical advantage, MA=Fout/Fin
Ideal Mechanical advantage, IMA, is where no work is lost
Work out = work in
Foutxdout=Finxdin
IMA = Fout/Fin = din/dout

efficiency = Wout/Win x 100%
= 100% for an ideal machine

eg. You use a jack (lever) to lift one wheel of a car off the ground to change the tire. The jack pushes on the car with 2000N to lift the wheel 0.10m. If you have to push with your hand on the jack through 1.5m,

a) what is the ideal mechanical advantage of the jack? (use the displacements)
b) what is the minimum force you would have to push on the jack to lift the car?
c) if you have to push with 150N, what is the mechanical advantage and efficiency of the jack?

a) IMA= din/dout = 1.5m/0.10m= 15X
b) Fout/Fin = 15X Fin = Fout/15 = 2000/15= 133.3333 = 133N
c) MA = Fout/Fin = 2000/150=13.3333 =13X
efficiency = wout/win x 100%
= Foutxdout/Finxdin x100%
= 2000Nx0.10m/150Nx1.5m x 100%
=89%